

# UNDERSTANDING AND USING THE HVAC DESIGN REVIEW FORM

## Load Calculation: Manual J Abridged Edition Equipment Selection: Heat Pump

The form below illustrates the Manual J Abridged Edition (AE) forms and the equipment selection process for a heat pump. The Manual JAE condenses the basic elements of the load calculation into a functional procedure to promote comprehension in students. Manual J1AE load calculations are valid however; they must meet all of the requirements on the Alternative Abridged Edition Check List (page 6).


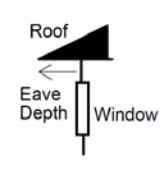
 <b>Residential Plans Examiner Review Form for HVAC System Design (Loads, Equipment, Ducts)</b>		Form RPER 1 15 Mar 09
County, Town, Municipality, Jurisdiction Header Information		
Contractor <u>ABC Heating and Air Conditioning Company</u> Mechanical License # <u>MCL# 123456789</u> Building Plan # <u>Model P54321-987, dated 13 June 2008</u> Home Address (Street or Lot#, Block, Subdivision) _____		<b>REQUIRED ATTACHMENTS</b> Manual J1 Form (and supporting worksheets): Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> or MJ1AE Form* (and supporting worksheets): Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> OEM performance data (heating, cooling, blower): Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Manual D Friction Rate Worksheet: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Duct distribution system sketch: Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
<b>HVAC LOAD CALCULATION (IRC M1401.3)</b>		
<b>Design Conditions</b> <b>Winter Design Conditions</b> Outdoor temperature <u>1</u> 31 °F Indoor temperature <u>2</u> 70 °F Total heat loss <u>14</u> 28,829 Btu <b>Summer Design Conditions</b> Outdoor temperature <u>3</u> 94 °F Indoor temperature <u>4</u> 75 °F Grains differ <u>5</u> 38 <u>6</u> 50 % Rh Sensible heat gain <u>15</u> 23,918 Btu Latent heat gain <u>16</u> 4,364 Btu Total heat gain 28,272 Btu		<b>Building Construction Information</b> <b>Building</b> Orientation (Front door faces) <u>North</u> North, East, West, South, Northeast, West, Southeast, Southwest Number of bedrooms <u>8</u> 2 Conditioned floor area <u>9</u> 1,200 Sq Ft Number of occupants <u>10</u> 3 <b>Windows</b> Eave overhang depth <u>11</u> 1.5 Ft Internal shade Blinds, light, 45 Angle Blinds, drapes, etc <u>12</u> 0 Number of skylights <u>12</u> 0 
<b>HVAC EQUIPMENT SELECTION (IRC M1401.3)</b>		
<b>Heating Equipment Data</b> Equipment type <u>Fan Coil/Air handler</u> Furnace, Heat pump, Boiler, etc. Model <u>19</u> XYZ FCA 030 & 5KW Heat Heating output capacity <u>20</u> 15,500 Btu Heat pumps - capacity at winter design outdoor conditions Auxiliary heat output capacity 17,065 Btu	<b>Cooling Equipment Data</b> Equipment type <u>22</u> Heatpump Air Conditioner, Heat pump, etc. Model <u>23</u> XYZ 030 Heatpump Latent cooling capacity 6,500 Btu Sensible cooling capacity <u>25</u> 21,200 Btu Total cooling capacity <u>26</u> 28,700 Btu	<b>Blower Data</b> Heating CFM 1,000 CFM Cooling CFM <u>28</u> 1,000 CFM Static pressure <u>29</u> 0.75 IWC Fan's rated external static pressure for design airflow
<b>HVAC DUCT DISTRIBUTION SYSTEM DESIGN (IRC M1601.1)</b>		
Design airflow <u>30</u> 1,000 CFM Equipment design ESP <u>31</u> 0.75 IWC Component Pressure Losses <u>32</u> 0.40 IWC Available Static Pressure <u>33</u> 0.35 IWC	Longest supply duct <u>34</u> 288 Ft Longest return duct <u>35</u> 150 Ft Total Effective Length <u>36</u> 438 Ft Friction Rate <u>37</u> 0.08 IWC <small>Friction Rate = (ASP × 100) ÷ TEL</small>	Duct Materials Used (circle) Trunk Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify) <u>2.5" Fiberglass duct board</u> Branch Duct: Duct board, Flex, Sheet metal, Lined sheet metal, Other (specify) <u>Sheet metal, R-8 Wrap</u>
I declare the load calculation, equipment selection, and duct system design were rigorously performed based on the building plan listed above, I understand the claims made on these forms will be subject to review and verification.		
Contractor's Printed Name <u>Bartholomew J. Simpson</u>		Date <u>1 April 2009</u>
Contractor's Signature _____		
<b>Reserved for County, Town, Municipality, or Authority having jurisdiction use.</b>		
<small>* Home qualifies for MJ1AE Form based on Abridged Edition Checklist.</small>		

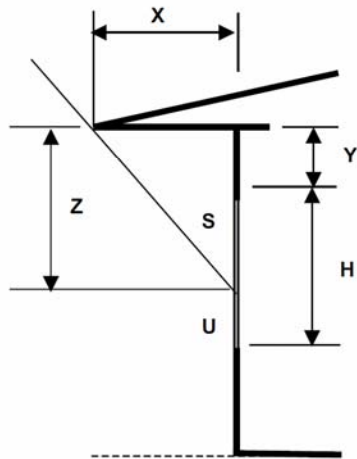
Figure 1: Sample Completed HVAC System Design Review Form – Manual J Abridged Edition (AE)

FORM J1ae										1) Room Name		Block Load		
ABRIDGED EDITION OF MANUAL J, 8TH EDITION										L, H & W in decimal feet and gross SqFt areas		Length	Height or Width	Gross Area
Project: Vatio Residence				Location: Houston, TX (airport)										
ACCA	2	Indoor db Heating	70	1	Latitude	29	DR	Medium	2) Exposed Wall		140	8	1120	
	4	Indoor db Cooling	75	3	99% db	31	HTD	39	3) Partition		18	8	144	
	6	Indoor RH Cooling	50%	5	1% db	94	CTD	19	4) Floor		40	30	1200	
		Elevation	96		Grains	51	ACF	1.00	5) Ceiling		Slope >	0	1200	
				Construction Number Direction & Details				Heating HTM	Cooling HTM	Net Area	Btuh Heating	Btuh Cooling		
6A	Windows & Glass Doors Load Area (SqFt) = 168.08			a	1E-c-mb (North-B1)				24.57	16.00	24.00	590	384	
				b	1D-c-mb (East A1)				25.35	39.93	36.00	913	1437	
				c	1D-c-mb (West C1; glass door)				25.35	46.00	44.33	1124	2039	
				d	1D-c-mb (West A2)				25.35	39.93	15.75	399	629	
				e	1D-c-mb (South A1)				25.35	14.40	36.00	913	518	
				f	1E-c-mb (South B2)				24.57	24.00	12.00	295	288	
				g										
				h										
				i										
				j										
				k										
				l										
6B	Skylights Load Area (SqFt) = 0.00			a										
				b										
				c										
				d										
7	Wood & Metal Doors Load Area (SqFt) = 42.00			a	11N metal door (North)				13.65	10.85	21.00	287	228	
				b	11N metal door (South)				13.65	10.85	21.00	287	228	
				c										
				d										
8	Above Grade Walls Load Area (SqFt) = 787			a	12C-2sw-stucco North				3.16	1.98	152	480	302	
				b	12C-2sw-stucco East				3.16	1.98	204	644	405	
				c	12C-2sw-stucco South				3.16	1.98	251	793	498	
				d	12C-2sw-stucco West				3.16	1.98	180	568	357	
				e										
				f										
	Partition Walls Load Area (SqFt) = 123			g	12C-2sw-stucco Garage				3.16	1.25	123	389	153	
				h										
9	Below Grade Walls Load Area (SqFt) = 0			a										
				b										
10	Ceilings Load Area (SqFt) = 1200			a	16B-30ad				1.25	1.76	1200	1498	2112	
				b										
				c										
	Partition Ceilings Load Area (SqFt) = 0			d										
				e										
11A	Passive Floors Load Area (SqFt) = 1200 Use feet of exposed edge for slab			a	22A-ph (slab, no insulation)				52.96		140	7415		
				b										
				c										
	Partition Floors Load Area (SqFt) = 0			d										
				e										
12	Infiltration Gross exposed wall area for WAR		1120	a	Envelope Leakage		Average	Infiltr Cfm for Heating	72	3089	769			
			b	No of Fireplaces		None	Infiltr Cfm for Cooling	37						
13	Internal Gains One occupant = 230 sensible Btuh		a	8		Number of bedrooms	2	10	# Occupants >	3		690 1200		
			b			Appliances (1200 Btuh or 2400 Btuh)								
14	Sub Totals (sum lines 6A through 13)											19682	12238	
15	Duct Loss / Gain:		7B-AE, R4, 0.35 / 0.70, with duct surface area adjustment					Factors >	0.46	0.81	9147	9973		
16	Ventilation		Maximum ventilation Cfm for MJ8ae is 50					Cfm for this job >		None				
19	Blower Heat Gain		Manufacturer's performance data has blower heat discount (1,707 if no, 0 if yes)											1707
20	Total Sensible Loss or Gain (sum lines 14 through 20)											14	28829	23918
				21	A) Latent Infiltration Gain (Btuh)							1276		
					B) Latent for Occupants (One occupant = 200 Btuh)							600		
					C) Latent for Plants (Small = 10, Med = 20, Large = 30)									
					D) Latent for Duct in Unconditioned Space							2488		
					E) Latent Ventilation Gain									
					F) Total Latent Gain (Btuh)							4364		

Figure 2: Manual J1AE Form

**Worksheet B: Heating and Cooling HTM and Load Area for Windows (flat, bay or garden) and Glass Doors (hinged, sliding or French)**

HTD	CTD	T3 CTD	Form J1ae, item 6A	Northerly Direction or Obviously Shaded by Overhang					
			Line ID (a, b, c, ... etc.)	a				b	c
Round CTD value for Table 3 lookup; use +1 or -1; or +2 or -2; as required (16 = 15; 17 = 15; 18 = 20; 19 = 20)			Direction glass faces	North				East	West
			Number of panes	2				2	2
			Frame type (w, m, mb, v)	mb				mb	mb
1) Table 2A construction number			To J1ae -->	1E-c-mb (North-B1)				1D-c-mb (East A1)	1D-c-n (West C glass c
2) Table 2A U-value				0.63				0.65	0.65
3) Unadjusted heating HTM = U x HTD				24.57				25.35	25.35
4) Heating HTM adjustment (see Note 1)				1.00				1.00	1.00
5) Adjusted heating HTM (L3 x L4)			To J1ae -->	24.57				25.35	25.35
6) Cooling HTM from Table 3A (default = blinds @ 45 deg)				16				46	46
7) Cooling HTM adjustment (see Note 2)				1.00				0.90	1.00
8) Adjusted C-HTM (L6 x L7)			N, NE, NW to J1ae -->	16.00				41.40	46.00
9) Area of opening (SqFt) for one unit				24.00				18.00	44.35
10) Number of identical assemblies				1				2	1
11) Net area of identical assemblies (L9 x L10)			To J1ae -->	24.00				36.00	44.35



If S is negative or zero, stop! Then copy the line 8 HTM to line 26

If S > H, jump to line 19; then copy the line 21 HTM to line 26

Internal shade same as used for Line 6

**Overhang (OH) Adjustment**

- 12) Opening height (H) in feet
- 13) Overhang length (X) in feet
- 14) SLM value for local latitude
- 15) Shade line to OH (Z) = L13 x L14
- 16) Distance below OH (Y)
- 17) Shaded height (S) = L15 - L16
- 18) Unshaded height (U) = L12 - L17
- 19) North HTM from Table 3A
- 20) HTM adjustment (copy line 7)
- 21) Adjusted North HTM (L19 x L20)
- 22) Shaded glass factor = L17 / L12
- 23) Unshaded glass factor = L18 / L12
- 24) Shaded HTM = L21 x L22
- 25) Unshaded HTM = L8 x L23

4.50		6.33
1.50		1.50
0.83		0.83
1.245		1.245
1.00		1.50
0.245		-0.25
4.255		
16		
0.90		
14.40		
0.054		
0.946		
0.78		
39.15		

To J1ae > 26) Effective HTM = L24 + L25

39.93		46.00
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Latitude	SLM Values for North Latitudes					
	25	30	35	40	45	50
E or W	0.83	0.83	0.82	0.81	0.80	0.79
SE or SW	1.89	1.63	1.41	1.25	1.13	1.10
South	10.10	5.40	3.53	2.60	2.05	1.70

Note 1: Default = 1.0; Bay window = 1.15; Garden window = 2.75; French door = 0.70

Note 2: Default = 1.0; Insect screen = 0.90; Bay window = 1.15; Garden window = 2.75

Figure 3: Portion of Manual J1 AE : Worksheet B

XYZ Performance Data						
Model 030 HP (Fan Coil FC030) 1,000 CFM						
OD Dry Bulb (F)	Indoor Entering Wet Bulb (F)	Total Capacity	Sensible Capacity at Entering Dry Bulb Temperature (F)			
			72	75	78	80
85	59	28,400	22,600	25,300	27,800	29,400
	63	29,900	18,800	21,600	24,300	26,100
	67	32,100	15,100	17,900	20,700	22,600
	71	34,700	11,400	14,200	17,000	18,900
95	59	27,300	22,200	24,900	27,400	28,300
	63	28,700	18,500	21,200	23,900	25,700
	67	30,800	14,700	17,500	20,400	22,200
	71	33,300	11,000	13,700	16,600	18,500
105	59	26,200	21,900	24,500	27,100	27,200
	63	27,600	18,100	20,900	23,600	25,400
	67	29,700	14,300	17,200	20,000	21,800
	71	32,100	10,600	13,300	16,200	18,100

OD Dry Bulb – Outdoor Dry Bulb, the outdoor temperature.

Correction Factors for other Airflows			
	Airflow	Total Capacity	Sensible Capacity
Low	875	0.98	0.93
High	1125	1.02	1.06

Multiply rated capacity data by factor.

Figure 4: Sample Heat Pump Cooling Performance Data

\* 75°F at 50% Rh ~ 63°F Wet bulb

XYZ 030 Heating Performance Data						
O.D. TEMP. F.	HEATING CAPACITY MBH AT INDOOR DRY BULB TEMP.			TOTAL POWER IN KILOWATTS AT INDOOR DRY BULB TEMP.		
	70	75	80	70	75	80
2	7.7	7.6	7.6	1.39	1.43	1.47
7	9.2	9.1	9.0	1.42	1.47	1.51
12	10.7	10.5	10.5	1.46	1.50	1.55
17	12.1	12.0	11.9	1.50	1.54	1.59
22	13.3	13.1	13.0	1.54	1.58	1.63
27	14.4	14.2	14.1	1.57	1.62	1.67
32	15.5	15.4	15.2	1.61	1.66	1.71
37	16.8	16.8	16.7	1.65	1.70	1.75
42	18.0	18.8	18.6	1.68	1.73	1.78
47	21.0	20.8	20.6	1.71	1.76	1.81
52	22.5	22.3	22.1	1.75	1.80	1.85
57	24.0	23.7	23.5	1.78	1.83	1.89
62	25.4	25.2	24.9	1.82	1.87	1.93
67	26.9	26.6	26.4	1.85	1.91	1.96
72	28.4	28.1	27.8	1.89	1.94	2.00

CORRECTION FACTORS FOR OTHER AIRFLOWS (MULTIPLY DATA BY FACTOR)			
	AIRFLOW	TOTAL CAPACITY	SENSIBLE CAPACITY
LOW	700	0.98	0.97
HIGH	900	1.01	1.02

Figure 5: Sample Heat Pump Heating Performance Data



## Manual D: Duct Design Worksheets

### Friction Rate Worksheet

#### Step 1) Manufacturer's Blower Data

External static pressure (ESP) =  $\frac{0.75 \text{ IWC}}{(31)}$       Cfm =  $\frac{1,000}{(30)}$

#### Step 2) Component Pressure Losses (CPL)

Direct expansion refrigerant coil	<u>0.18</u>
Electric resistance heating coil	<u>      </u>
Hot water coil	<u>      </u>
Heat exchanger	<u>      </u>
Low efficiency filter	<u>      </u>
High or mid-efficiency filter	<u>0.13</u>
Electronic filter	<u>      </u>
Humidifier	<u>      </u>
Supply outlet	<u>0.03</u>
Return grille	<u>0.03</u>
Balancing damper	<u>0.03</u>
UV lights or other device	<u>      </u>

Total component losses (CPL) =  $\frac{0.40}{(32)}$  IWC

#### Step 3) Available Static Pressure (ASP)

ASP = (ESP - CPL) = ( 0.75 - 0.40 ) =  $\frac{0.35}{(33)}$  IWC

#### Step 4) Total Effective Length (TEL)

Supply-side TEL + Return-side TEL = ( 288 + 150 ) = 438 Feet  
(34)      (35)      (36)

#### Step 5) Friction Rate Design Value (FR)

FR value from friction rate chart =  $\frac{0.08 \text{ IWC}/100}{(36)}$

$$FR = \frac{ASP \times 100}{TEL}$$

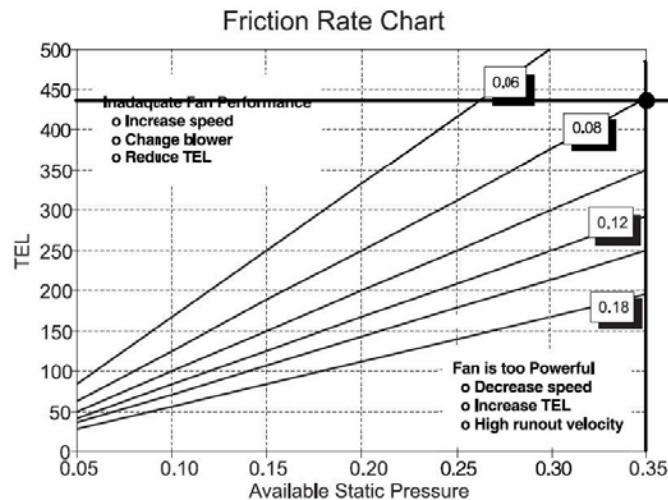


Figure 6: Manual D Friction Rate Worksheet

Alternative Abridged Edition Check List	
The abridged procedure was used, I have initialed next to each block to indicate this dwelling meets each criteria.	
	ONLY a single family detached dwelling.
	HVAC system is a central, single-zone, constant volume system.
	NO radiant heating system.
	NO ventilation heat exchanger (ERV or HRV) or a ventilating dehumidifier.
	ONLY engineered ventilation allowed is provided by piping outdoor air to the return side of the duct system (pressurization effect on infiltration is ignored).
	The indoor design conditions are: Heating 70 °F; Cooling 75 db °F and 45%, 50% or 55% RH.
	ONLY outdoor design conditions equal to the values in Table 1A were used.
	TOTAL window area (including glass doors and skylight area) does not exceed 15 percent of the associated floor area.
	The windows are equitably distributed around all sides of the dwelling — the dwelling has sufficient exposure diversity.
	NO Low-e, tinted, reflective, or special glass (All windows, skylights, and glass doors must be clear 1-pane, 2-pane or 3-pane glass)
	ALL skylights are flat. NO skylight light shafts or internal shade.
	ALL windows' internal shade factor is a medium-color blind with slats at 45 degrees.
	ALL U-values and SHGC values for all windows, skylights, and glass doors are from Table 3A and 3C.
	ALL purpose-built daylight windows and skylights have no internal shade.
	ALL windows and glass doors are calculated with applicable bug screen, French door, and projection adjustments.
	NO glass external sun screens.
	ALL windows and glass doors are calculated with applicable overhang adjustments.
	ALL above grade walls are wood frame walls or empty-core block walls (no metal framing, no filled core block).
	ALL exterior finish is brick, stucco, or siding.
	ONLY gypsum board was used for the interior finish.
	ALL below grade walls are empty-core block walls (board insulation; framing and blanket insulation).
	ALL framing is wood (not metal).
	ONLY a dark shingle roof over an attic, a beam ceiling or a roof-joist ceiling.
	ONLY attic or attic knee wall space (when applicable) vented to FHA standards, with no radiant barrier.
	ONLY slab floors with no edge insulation (or 3 feet of vertical insulation that covers the edge). NO insulation below basement floors slab, no sensitivity to width.
	NO insulation under floors over a closed space or on the walls of the closed space.
	Floors over a closed space are insensitive to the tightness of the closed space.
	ONLY infiltration load estimates based on Table 5A (three or four exposures, class 4 wind shielding, no blower door
	ONLY a sensible appliance load of 1,200 or 2,400 Btuh
	ONLY number of occupants is the number of bedrooms plus one.
	ONLY allowed duct systems (when applicable) are: a. installed in one horizontal plane; b. entirely in a conditioned
	ONLY one of the following duct runs were used: a. An attic installed radial or spider pattern supply system (supplies in room centers) and returns (large return close to air handler or return in closet door); OR b. A trunk and branch supply system in the attic (supplies near inside walls; return riser in floor to ceiling chase); OR c. A trunk and branch supply system in a closed crawlspace or unconditioned basement.
	ONLY the duct leakage rate of $R/A=0.12$ $S/A = 0.24$ was used, unless proven by a leakage test.
	ONLY the following duct insulation: R-2, R-4, R-6, or R-8.
	ONLY blower heat adjustment is 500 Watts, if manufacturer's performance data is not discounted for blower heat.
<b>Note:</b> The abridged edition of <i>Manual J</i> (MJ8ae) shall ONLY be used to estimate heating and cooling loads for dwellings which are totally compatible (100 percent) with this checklist and the descriptions and caveats provided by Appendix 2 and 3. The full version of <i>Manual J</i> will be used for all other scenarios.	

Figure 7: Manual J Abridged Edition Checklist